INSTRUCTIONS

GOVERNOR DRIVE (WITH BARRING-OVER FEATURE) FOR GE DIESEL ENGINES

PART 114X1200

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DATA 12

FIG. 1, E-23479

SCOPE

This instruction covers the change-out of the governor drive assembly on the locomotive and the overhaul of the drive assembly in the back shop. It does not cover the operation of the barring-over feature. This is covered appropriately under CAMSHAFT TIMING in SECTIONALIZED CAMSHAFT in Section DE-5; under ADJUSTING TAPPET CLEARANCE in ENGINE CYLINDERS in Section DE-7; and under PUMP TIMING in FUEL INJECTION SYSTEM, ENGINE-MOUNTED ITEMS in Section DE-14.

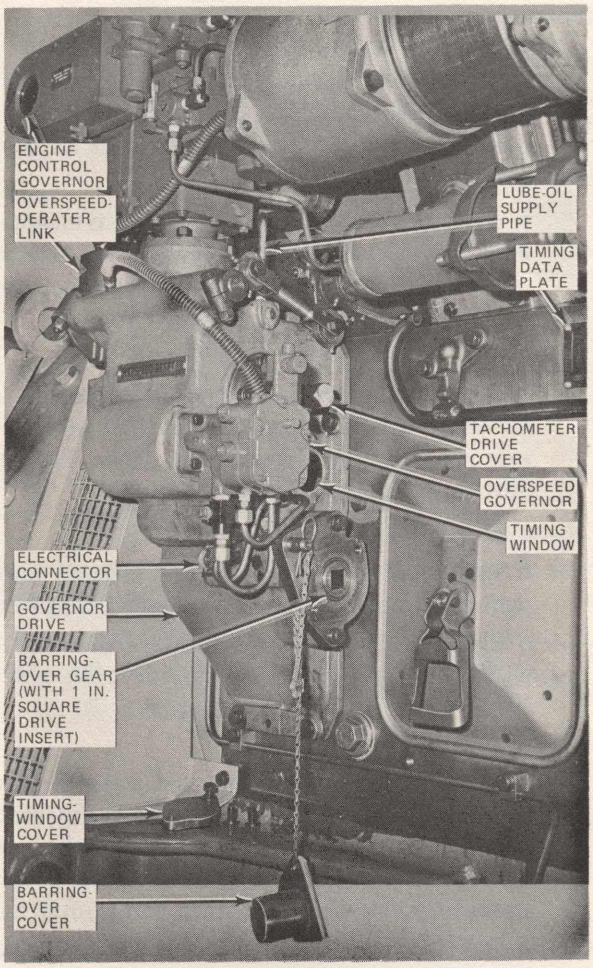
ENGINE CONTROL GOVERNOR
OVERSPEED-DERATER LINK
LUBE-OIL SUPPLY PIPE
TIMING DATA PLATE
TACHOMETER DRIVE COVER
OVERSPEED GOVERNOR
TIMING WINDOW
ELECTRICAL CONNECTOR
GOVERNOR DRIVE
BARRING-OVER GEAR (WITH 1 IN. SQUARE DRIVE INSERT)
TIMING-WINDOW COVER
BARRING-OVER COVER

FIG. 1. GOVERNOR DRIVE MOUNTED ON ENGINE.

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*Revisions are indicated by marginal bars.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

Verify numbers for parts, tools, or material by using the Renewal Parts or Tool Catalogs, or contact your General Electric representative for assistance. Do not order from this publication.

DESCRIPTION

GENERAL

The governor drive subassembly is located on the right side of the engine, at the rear or drive end. It is positioned by two locating dowels and secured by bolts to the main frame.

The governor drive has the following features and functions:

1. It drives the engine control governor which is mounted on top of the governor drive. The speed ratio of the governor to the crankshaft is 1.1037 to 1.
2. It drives the overspeed governor which is mounted on the forward side of the governor drive. The speed ratio of the overspeed governor to the crankshaft is 3.4666 to 1.
3. It has an SAE-type tachometer drive, accessible after removing the cover on the forward side of the governor drive. The speed ratio of the tachometer drive to the crankshaft is 1.4857 to 1.
4. It has a gear-shaft which can be engaged with the right-bank camshaft gear to facilitate barring over the engine. When the engine is running, this gear-shaft is moved to a disengaged position by the action of engine lube-oil pressure.
5. It has an electrical connector and a switch which is closed when the barring-over cover is installed; the switch opens when the cover is removed. This serves as an interlock in the engine cranking circuit to prevent starting the engine when barring-over tooling is installed on the engine.

CONSTRUCTION

A special gray-iron, cast gear box has bored fits into which are assembled renewable bronze bearings. These bearings support the gears on the shafts which mount the gears.

The right-bank camshaft gear drives the main driven gear which is mounted on the main horizontal shaft. This shaft has an SAE tachometer drive machined in its forward end and a bevel gear machined on its rear end. The bevel gear drives another bevel gear to rotate the vertical shaft which, in turn, drives the engine control governor.

The main driven gear also drives a smaller gear mounted on a second horizontal shaft. This shaft drives the overspeed governor.

Another gear, not connected in the gear train, moves in a forward or aft direction to engage, or disengage, the right-bank camshaft gear to serve the engine barring-over function.

LUBRICATION

Engine lube oil (at header pressure) is piped to a connection point in the top, forward portion of the governor drive. This oil is delivered thru drilled passages and a pipe connection (Fig. 14) to the bearings of the vertical and horizontal shafts, to the cast-in oil reservoir, and to the rear face of the barring-over gear, thus forcing it forward and out of engagement during engine operation.

Bearings for the fuel-control shaft receive splash and mist lubrications, as do the gear teeth.

Oil from the cast-in reservoir is also supplied by piping to the overspeed governor. This oil lubricates the overspeed governor and serves as the fluid used in the engine overspeed system.

ENGINE SPEED MEASUREMENT

Proportional engine crankshaft speed may be measured by applying a tachometer to the tachometer drive in the end of the main horizontal shaft. Divide the tachometer reading by 1.4857 to determine the true crankshaft speed.

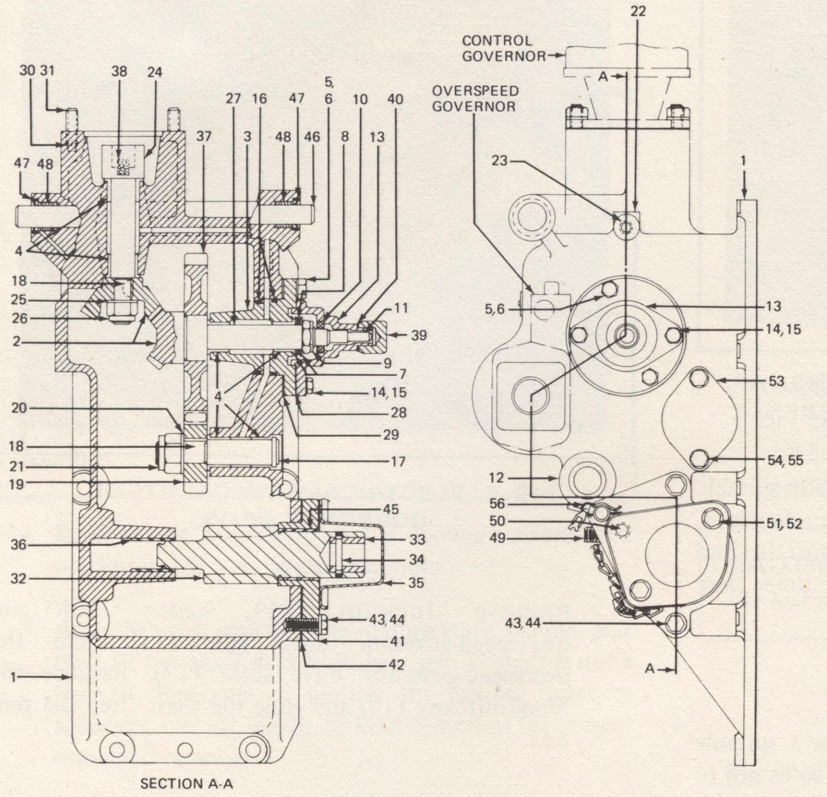
REMOVING GOVERNOR DRIVE FROM ENGINE

With the engine shut down:

1. Disconnect the electrical connectors at the lower, front location on the gear box (see Fig. 1).

CAUTION: *The preceding operation is mandatory before continuing with the operations that follow, since this will open the engine cranking circuit and prevent the engine from accidentally being cranked and started.*

2. Remove the control governor and overspeed-derater link.
3. Remove the overspeed governor.
4. Disconnect the fuel-control linkage.



REF.	DESCRIPTION
1	GEAR BOX
2	BEVEL GEARS
3	BEARING CAP
4	BEARINGS
5	BEARING-CAP MOUNTING BOLTS
6	BEARING-CAP LOCKWASHERS
7	FLAT WASHERS
8	SPRING WASHER
9	HORIZONTAL-SHAFT LOCKNUT
10	SEAL
11	TACHOMETER DRIVE (IN END OF HORIZONTAL SHAFT)
12	CAST-IN OIL RESERVOIR
13	TACHOMETER ADAPTER
14	TACHOMETER-ADAPTER MOUNTING BOLTS
15	TACHOMETER-ADAPTER LOCKWASHERS
16	O-RINGS
17	OVERSPEED-GOVERNOR DRIVE SHAFT
18	WOODRUFF KEYS
19	OVERSPEED-GOVERNOR DRIVE GEAR
20	FLATWASHER
21	LOCKNUT
22	LUBE-OIL CONNECTION POINT
23	PIPE PLUG
24	VERTICAL SHAFT
25	FLATWASHER
26	LOCKNUT
27	HORIZONTAL SHAFT
28	GASKET
29	SHIMS
30	LOCKWASHERS
31	STUDS
32	BARRING-OVER GEAR
33	SQUARE-DRIVE INSERT
34	SHEAR PIN
35	BARRING-OVER COVER
36	BEARING
37	MAIN DRIVEN GEAR
38	SPRING
39	TACHOMETER-DRIVE CAP
40	GASKET
41	BEARING CAP
42	GASKET
43	BEARING-CAP MOUNTING BOLTS
44	BEARING-CAP LOCKWASHERS
45	BEARING
46	FUEL-CONTROL SHAFT
47	SEALS
48	BEARINGS
49	ELECTRICAL CONNECTOR
50	BARRING-OVER SWITCH
51	COVER MOUNTING BOLTS
52	COVER LOCKWASHERS
53	TIMING-WINDOW COVER
54	COVER MOUNTING BOLTS
55	COVER LOCKWASHERS
56	LOCKING PIN (FOR PNEUTORQUE BARRING-OVER TOOL)

FIG. 2. GOVERNOR DRIVE, CROSS-SECTIONAL VIEW.

FIG. 2, E-23480

5. Disconnect all oil lines between the governor drive assembly and the engine.

6. Remove the mounting bolts, carefully work the drive assembly from the locating dowels, and lift from the engine.

DISASSEMBLY OF ELECTRICAL COMPONENTS
(See Fig. 2 and 6)

1. Remove barring-over cover (35) by removing bolts (51) and lockwashers (52).

2. Remove bearing-cap mounting bolts (43) and lockwashers (44).

3. Install two 1/2 in.-13 bolts in the tapped holes provided in the bearing cap, and jack the bearing cap from its position in the gear box (1).

4. When the bearing cap is partially removed from the gear box, disconnect the two conductors from the switch (Fig. 6). After wires are disconnected, complete the removal of the bearing cap, with the barring-over gear (32), from the gear box.

5. Remove the switch from the bearing cap and remove the electrical connector, with attached conductors, from the gear box.

DISASSEMBLY OF MECHANICAL COMPONENTS
(See Fig. 2)

Before beginning mechanical disassembly, remove the electrical components (see DISASSEMBLY OF ELECTRICAL COMPONENTS section), then remove the major portion of dirt accumulation from the drive assembly, using steam or other suitable method.

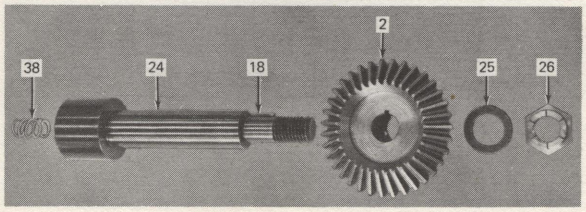


FIG. 3. VERTICAL SHAFT COMPONENTS. (SEE FIG. 2 FOR REFERENCE NUMBER TABULATION).

FIG. 3, E-16367B

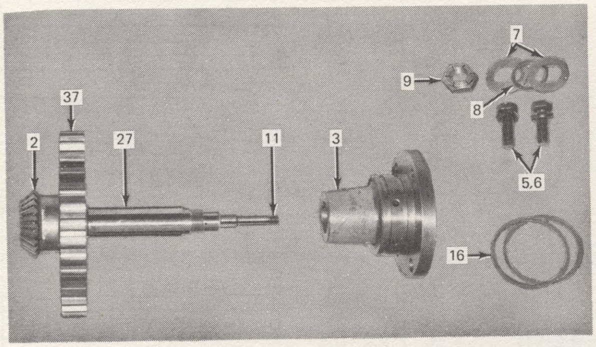


FIG. 4. HORIZONTAL SHAFT AND BEARING CAP, WITH HARDWARE. (SEE FIG. 2 FOR REFERENCE NUMBER TABULATION).

When disassembling the drive, place the parts in suitable containers to prevent them from becoming lost or damaged. After cleaning, cover parts to protect them against dirt and moisture. If they are to be stored for some time, they should be properly protected against rusting.

Disassemble the drive as follows:

1. Mount the gear box upright in a vise or a suitable holding fixture. Use care when clamping so as not to damage the casting.
2. Remove one lever from the fuel-control shaft, and slip the shaft from its bearings.
3. Unbolt the tachometer adapter (13) and remove it with seal (10) from the gear box (1).
4. Remove the horizontal shaft locknut (9) and washers (7 and 8) from the horizontal shaft.
5. Unbolt the bearing cap (3) and jack it from the gear box, using jacking screws in the holes provided. Apply even force to the screws.
6. Slide the horizontal shaft (27) from the bearing cap (3) while removing the bearing cap from the gear box.

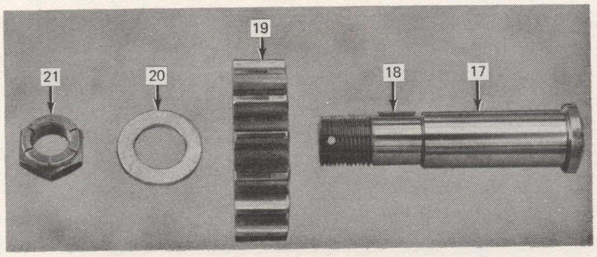


FIG. 5. OVERSPEED-GOVERNOR DRIVE COMPONENTS. (SEE FIG. 2 FOR REFERENCE NUMBER TABULATION).

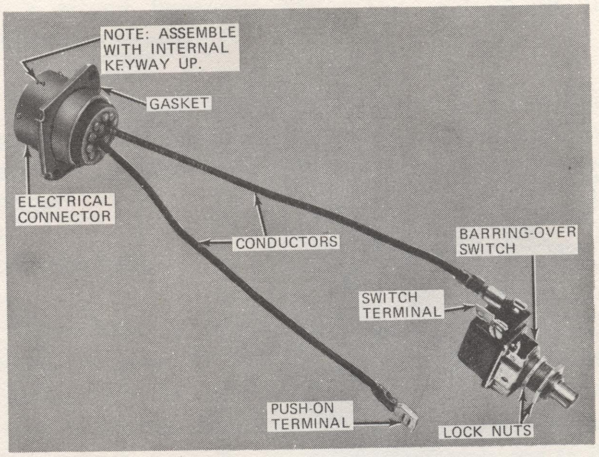


FIG. 6. ELECTRICAL COMPONENTS OF GOVERNOR DRIVE.

7. Remove locknut (21), washer (20), and overspeed-governor drive gear (19) from the overspeed-governor drive shaft (17). Remove the Woodruff key (18) and slide the shaft from the gear box.
8. Remove locknut (26), washer (25), and bevel gear (2) from the vertical shaft (24). Slide the vertical shaft (24) from the gear box. Remove spring (38) from the upper end of the shaft.

CLEANING

Clean all the parts thoroughly, including the gear box. Pay special attention to the oil passages within the box and other parts. Repainting the inner surfaces of the box is not recommended.

INSPECTION

Inspect the following items and renew if necessary.

1. All sleeve bearings, for wear.
2. Shafts, for being bent, and shaft bearing journals for wear, scoring, galling or signs of overheating.
3. Gears, for excessive or uneven wear, pitting, scuffing or broken teeth.

FIG. 4, E-25061

FIG. 5, E-16370A

FIG. 6, E-23481

RENEWING BEARINGS AND SEALS

FUEL CONTROL SHAFT BEARINGS

1. Hack saw thru most of the thickness of the bearing wall, then drive the bearing from its location in the gear box.

2. Remove any burrs or upset metal, if present, in the bearing bore in the gear box.

3. Shrink the bearing in a sub-freezer or liquid nitrogen.

> **WARNING:** *To prevent personal injury, wear protective gloves when handling super-cooled bearings.*

4. Remove the bearing from the cooling medium and quickly install it in its gear-box bore.

5. After bearing assumes the temperature of the gear box, fit the shaft thru both bearings. If shaft is not a free fit, line-ream or burnish the bearing bores to achieve a free fit. Refer to DATA section for correct running clearance.

BEARINGS FOR HORIZONTAL, VERTICAL AND OVERSPEED-GOVERNOR SHAFTS

1. Follow Steps 1 thru 4 under Fuel Control Shaft Bearings section, given above.

2. Line-ream or burnish the bearing bores so they will accept a 1.1263 in. (28,608 mm) diameter mandrel. Mandrel must be long enough to engage both bearings.

BEARINGS FOR BARRING-OVER GEAR

1. Follow Steps 1 thru 4 under Fuel Control Shaft Bearings section, given above.

2. If required, ream or burnish the bearing bores to achieve the bore size and running clearance specified in the DATA section.

OIL SEALS

1. Use a seal-puller tool or carefully pry the worn seal from its location in the tachometer adapter or the gear box.

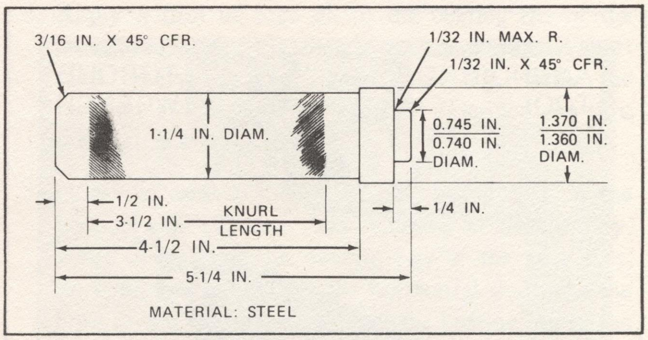

3/16 IN. X 45° CFR.
1/32 IN. MAX. R.
1/32 IN. X 45° CFR.
1-1/4 IN. DIAM.
0.745 IN.
0.740 IN.
DIAM.
1.370 IN.
1.360 IN.
DIAM.
1/2 IN.
3-1/2 IN.
KNURL LENGTH
4-1/2 IN.
1/4 IN.
5-1/4 IN.
MATERIAL: STEEL

FIG. 7. TACHOMETER-DRIVE SEAL-DRIVING TOOL, PART 147X2065.

FIG. 7, E-21479

2. Install a new seal by driving it squarely into the bore of the tachometer adapter or the gear box. A seal-driving tool (Fig. 7 or 8) is recommended for this operation.

> **CAUTION:** *Use extreme care so as not to distort the seal ring or damage the rubber lip.*

RENEWING GEARS

The main drive gear on the horizontal shaft is secured with an interference fit, while the gears on the vertical shaft and the overspeed-governor shaft are slip-fit and secured with a washer and locknut. Refer to the DATA section for fit values.

The main drive gear must be removed using suitable spacer sleeves, parallel spacer bars, and a press capable of applying five tons pressure.

> **CAUTION:** *To prevent shaft bending or damage when removing or assembling the main drive gear, apply force squarely to the shaft and gear.*

The main drive gear can be assembled on the horizontal shaft using the press method, or by heating the gear sufficiently to expand the bore and allow hand assembly.

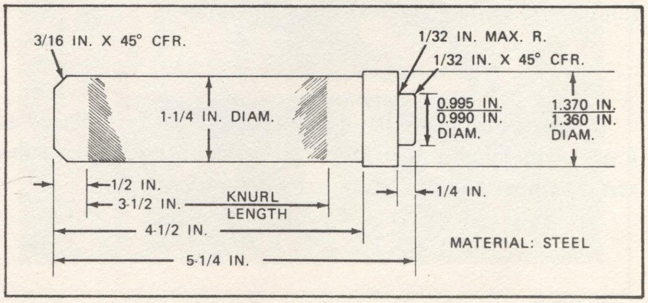

3/16 IN. X 45° CFR.
1/32 IN. MAX. R.
1/32 IN. X 45° CFR.
1-1/4 IN. DIAM.
0.995 IN.
0.990 IN.
DIAM.
1.370 IN.
1.360 IN.
DIAM.
1/2 IN.
3-1/2 IN.
KNURL LENGTH
4-1/2 IN.
1/4 IN.
5-1/4 IN.
MATERIAL: STEEL

FIG. 8. FUEL-CONTROL-SHAFT SEAL-DRIVING TOOL, PART 147X2133.

FIG. 8, E-23482

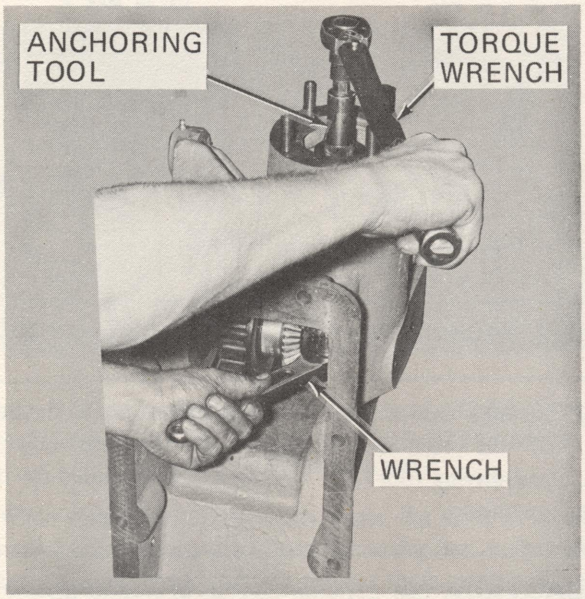

ANCHORING TOOL
TORQUE WRENCH
WRENCH

FIG. 9. TIGHTENING VERTICAL SHAFT LOCKNUT.

FIG. 9, E-21480

> **WARNING:** *To prevent personal injury, wear protective gloves when handling the heated gear.*

> **CAUTION:** *Temperature of gear must not exceed 475 F (246 C) as such temperatures will anneal the metal and cause excessive rate of wear.*

When replacing the gear on the vertical shaft or the overspeed-governor shaft, it is necessary to anchor the shaft while removing and assembling the locknut. Fig. 9 shows one method of anchoring the vertical shaft; Fig. 10 shows details for making the anchoring tool. Fig. 11 shows one method of anchoring the overspeed-governor shaft; Fig. 12 shows details for making the anchoring tool. With such tooling, the shaft can be held stationary and the nut tightened, or the nut can be held stationary and the tool (and shaft) turned to effect nut tightening.

When renewing the bevel gears, they must be replaced as a set. A matched set of gears can be identified by the same serial number and pair number etched on each gear.

NOTE: *The horizontal half of the bevel gear set is an integral part of the horizontal shaft.*

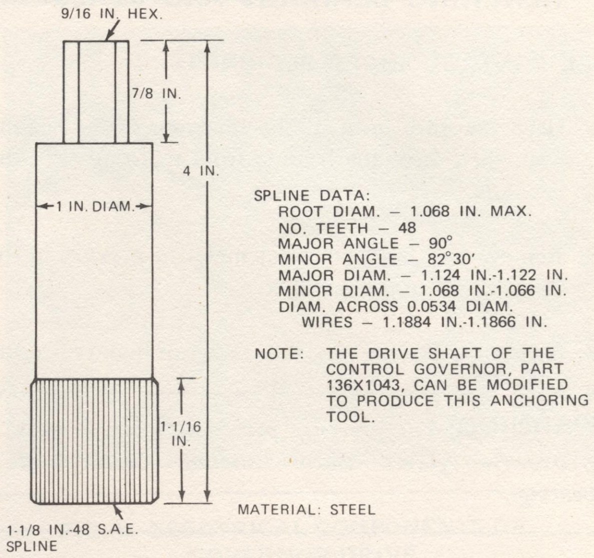

9/16 IN. HEX.
7/8 IN.
4 IN.
1 IN. DIAM.
SPLINE DATA:
ROOT DIAM. – 1.068 IN. MAX.
NO. TEETH – 48
MAJOR ANGLE – 90°
MINOR ANGLE – 82°30′
MAJOR DIAM. – 1.124 IN.-1.122 IN.
MINOR DIAM. – 1.068 IN.-1.066 IN.
DIAM. ACROSS 0.0534 DIAM. WIRES – 1.1884 IN.-1.1866 IN.
NOTE: THE DRIVE SHAFT OF THE CONTROL GOVERNOR, PART 136X1043, CAN BE MODIFIED TO PRODUCE THIS ANCHORING TOOL.
1-1/16 IN.
MATERIAL: STEEL
1-1/8 IN.-48 S.A.E. SPLINE

FIG. 10. VERTICAL SHAFT ANCHORING TOOL, PART 147X2064.

FIG. 10, E-21481

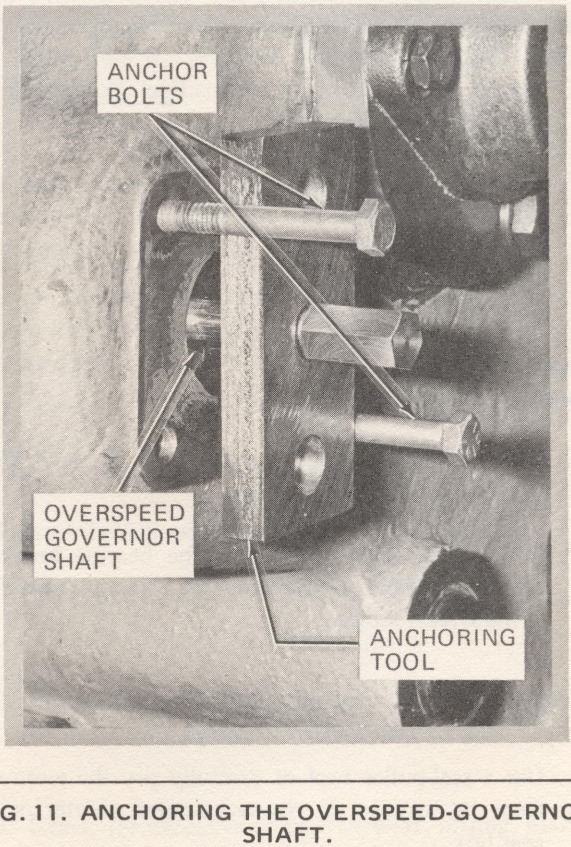

ANCHOR BOLTS
OVERSPEED GOVERNOR SHAFT
ANCHORING TOOL

FIG. 11. ANCHORING THE OVERSPEED-GOVERNOR SHAFT.

FIG. 11, E-21614

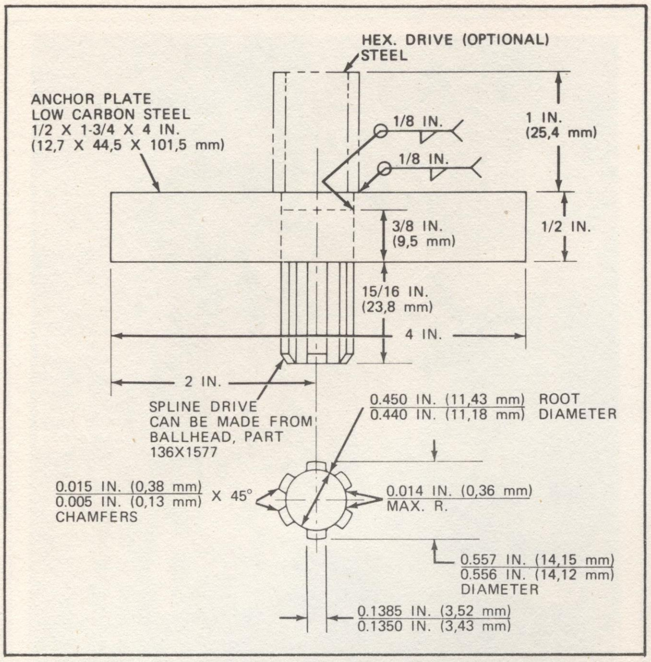

HEX. DRIVE (OPTIONAL) STEEL
ANCHOR PLATE
LOW CARBON STEEL
1/2 X 1-3/4 X 4 IN.
(12,7 X 44,5 X 101,5 mm)
1/8 IN.
1/8 IN.
1 IN.
(25,4 mm)
3/8 IN.
(9,5 mm)
1/2 IN.
15/16 IN.
(23,8 mm)
4 IN.
2 IN.
SPLINE DRIVE
CAN BE MADE FROM
BALLHEAD, PART
136X1577
0.450 IN. (11,43 mm) ROOT
0.440 IN. (11,18 mm) DIAMETER
0.015 IN. (0,38 mm)
0.005 IN. (0,13 mm) X 45°
CHAMFERS
0.014 IN. (0,36 mm)
MAX. R.
0.557 IN. (14,15 mm)
0.556 IN. (14,12 mm)
DIAMETER
0.1385 IN. (3,52 mm)
0.1350 IN. (3,43 mm)

FIG. 12. HORIZONTAL SHAFT ANCHORING TOOL, PART 147X2132.

FIG. 12, E-21478

REASSEMBLY (See Fig. 2)

Assemble the governor drive, using new shims, gaskets, and O-rings, in the following manner:

1. Mount the gear box in a vise or a suitable holding fixture. Use care when clamping so as not to damage the casting.

2. Check the fit of the Woodruff key (18) in the overspeed-governor shaft (17), and check the fit of the gear (19) on the shaft (17). Both parts must be free-fitting. After checking, remove both parts from the shaft. Apply a film of lube oil to the shaft bearing fits and assemble it in the gear box (1). Then assemble the Woodruff key, gear, washer (20) and locknut (21). Using the anchoring tool (Figs. 11 and 12), tighten the locknut to the torque value given in the DATA section.

3. With the Woodruff key (18) assembled in the vertical shaft (24), apply a film of lube oil to the shaft bearing fits, and install the shaft downward thru the upper bore in the gear box (1). Assemble the vertical half of the bevel gear set (2), washer (25) and locknut (26). Using the anchoring tool (Fig. 9 and 10), tighten the locknut to the torque value given in the DATA section.

4. Apply a film of lube oil to the bearing fits of the horizontal shaft (27), then loosely position the shaft (and gears) in the gear box (1), with the tachometer-drive end of the shaft extended out thru the bearing-cap opening.

5. Place the same thickness of new shims (29) on the bearing cap (3) that was removed at disassembly. While assembling the bearing cap in the gear box, simultaneously assemble the horizontal shaft into the bore of the bearing cap. Secure the bearing cap to the gear box (1) using bolts (5). Make certain face of bearing cap is in perfect contact with shims and gear-box face, or else it will have an adverse effect on the backlash readings.

NOTE: *The above is a trial assembly and is made to check gear backlash. Do not use O-rings or lockwashers for this assembly.*

6. Check backlash of main drive gear to overspeed-shaft gear, and the backlash between the beveled gears (Fig. 13). When checking the beveled gear backlash, the vertical shaft must be at the extreme DOWN position and the horizontal shaft must be at the extreme FORWARD position, since this is the normal running position for these gears. There is no adjustment of the backlash between the main drive gear and the overspeed-shaft gear; backlash between the two beveled gears is varied by varying the thickness of the shim pack (29) between the bearing cap and the gear box. Refer to DATA section for backlash limits.

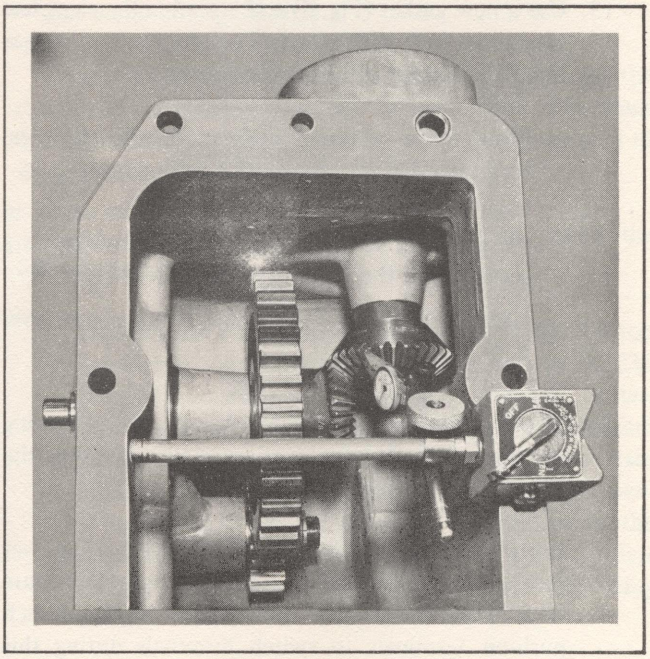


FIG. 13. MEASURING BACKLASH ON BEVELED GEARS.

FIG. 13, E-16371

7. After proper backlash is obtained, remove the bearing cap (3) from the gear box (1), install two new O-rings (16) in the outside diameter of the bearing cap, and apply a film of lube oil to the bearing-cap bore of the gear box. Reassemble the bearing cap (together with the horizontal shaft and gear) in the gear box, and secure with bolts (5) and lockwashers (6).

8. Assemble two flat washers (7), spring washer (8), and locknut (9). Tighten locknut to the torque value given in the DATA section.

9. Recheck the backlash. If still within correct limits, assemble new gasket (28), tachometer adapter (13), and secure with bolts (14) and lockwashers (15). Using new gasket (40), assemble tachometer adapter cap (39).

10. Assemble the fuel-control shaft (46) and the lever removed at disassembly.

11. Apply several drops of clean oil to the bearings and gears, and rotate the drive by hand. All moving parts should turn freely, without binding or catching. If they do not, locate and correct the cause before the drive is assembled to the engine.

12. Assemble the barring-over switch (Fig. 6) to the bearing cap (41) and secure with the switch locknuts. Position locknuts so switch button is 1/8 in. below the outer face of the bearing cap.

13. Use a new gasket (Fig. 6) and assemble the electrical connector (49) with attached conductors to the gear box (1). While performing this operation:
    a. Position the internal keyway in the electrical connector UP (at 12 o'clock position) and
    b. Feed the electrical conductors thru the cavity in the gear box so conductor push-on terminals are accessible at the forward end of the cavity.
    c. Loosely install a rubber insulating sleeve over both conductors.

14. Apply a film of clean engine lube oil to both bearing surfaces on the barring-over gear (32). Assemble the gear into its bearing cap (41).

15. Use a new gasket (42) and assemble the barring-over gear and its bearing cap into the gear box (1). Secure with bolts (43) and lockwashers (44). Attach push-on terminals to switch terminals during this assembly operation and move the rubber insulating sleeve over the terminals and switch body against the bearing-cap surface. Check barring-over gear for freedom to rotate and freedom to move axially.

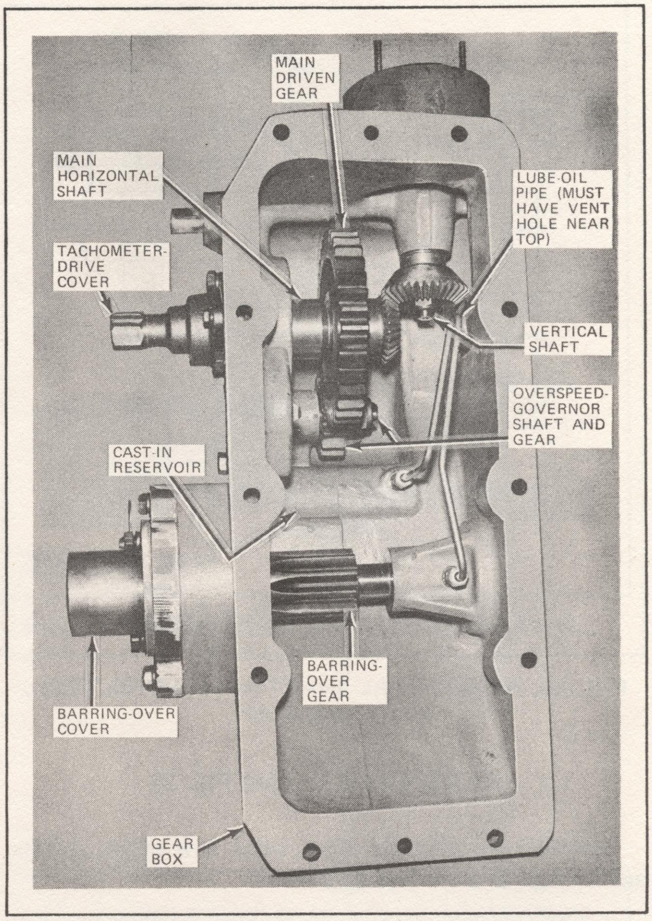


FIG. 14. ASSEMBLED GOVERNOR DRIVE, BACK VIEW.

FIG. 14, E-23483

16. Assemble the barring-over cover (35) and secure with bolts (51) and lockwashers (52). While performing this operation, check to assure that the projection on the cover operates the switch to CLOSE the switch contacts. Verify switch operation with an ohmmeter at the two pins in the electrical connector (49).

See Figs. 14 and 15 for views of assembled gear box.

STORAGE

If some time will elapse before the drive is assembled to an engine, it should be properly protected against dirt and moisture. Apply plugs to the oil pipe connections, coat the machined surfaces with a rust-preventive oil, and seal the assembly in a protective wrapping.

INSTALLING GOVERNOR DRIVE ON ENGINE

In general, the governor drive is installed in the reverse order of its removal. The mounting faces of both the main frame and the gear box must be clean and free of all old

FIG. 15, E-23484

FIG. 16, E-21468A

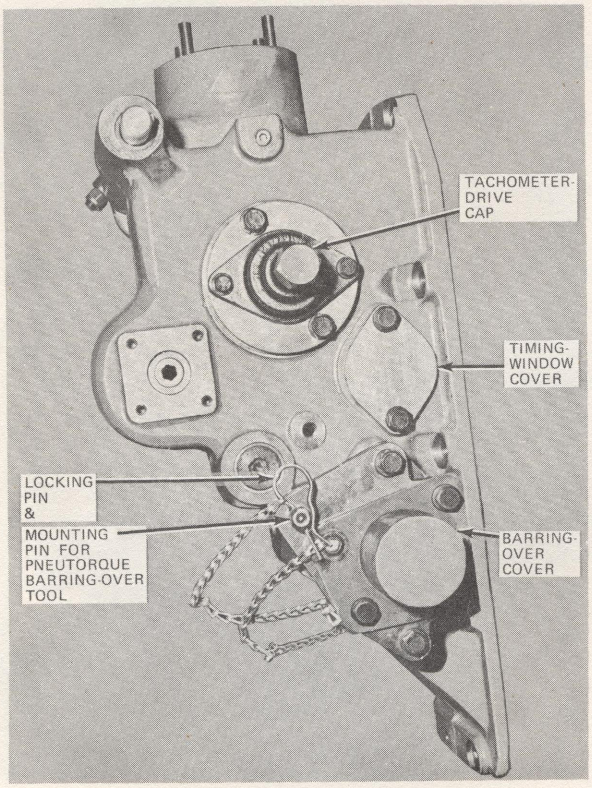

TACHOMETER-DRIVE CAP
TIMING-WINDOW COVER
LOCKING PIN & MOUNTING PIN FOR PNEUTORQUE BARRING-OVER TOOL
BARRING-OVER COVER

FIG. 15. ASSEMBLED GOVERNOR DRIVE, FORWARD SIDE.

gasket material. Assemble a new gasket on the face of the main frame. Position the governor drive over the locating dowels and secure it with bolts and lockwashers.

Check the backlash between the main drive gear and the camshaft gear. See DATA section for backlash values. Use tooling as shown in Fig. 16 for measuring the amount of backlash. This tooling consists of:

1. A notched wheel with a shaft that engages the tachometer-drive shaft. The outside diameters of the notched wheel and the main drive gear are equal.
2. A driver that engages the overspeed-governor drive shaft which, in turn, allows rotation of the gear train.
3. A dial indicator whose button engages one of the notches in the notched wheel.

With the above arrangement, the free movement of the gears (backlash) is measured at the notch in the notched wheel. This method of measuring is possible, because both the main drive gear and the notched wheel engage a common shaft.

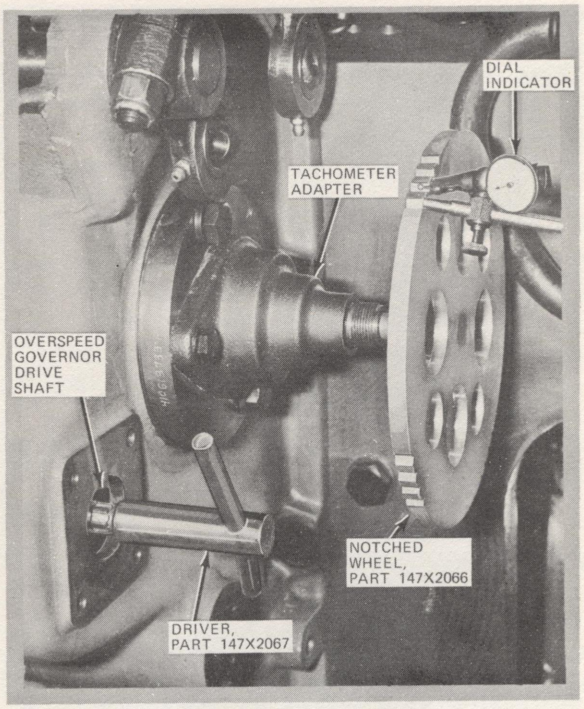

DIAL INDICATOR
TACHOMETER ADAPTER
OVERSPEED GOVERNOR DRIVE SHAFT
NOTCHED WHEEL, PART 147X2066
DRIVER, PART 147X2067

FIG. 16. CHECKING BACKLASH BETWEEN MAIN DRIVE GEAR AND CAMSHAFT GEAR.

NOTE: *If the backlash between the main drive gear and the camshaft gear exceeds 0.050 in. (1,270 mm), re-dowel the governor drive to the engine main frame to get the backlash between 0.008 in. (0,203 mm) and 0.050 in. (1,270 mm).*

Check for backlash between the barring-over gear and the right-bank camshaft gear. While the exact value of backlash is not critical, it is mandatory that some free movement of the gears (backlash) does exist.

Reset the pointer (Fig. 17), if required, using the following procedure:

1. Position the crankshaft so the No. 1R piston is at top dead center and firing. Use tram gage, Part 147X1230 (Fig. 18), to position the piston at top dead center, then check the position of the inlet and exhaust cam rollers on their cams. If both rollers are on the base circles of the cams, the piston is on the firing stroke. If rollers are not on the base circles, rotate the crankshaft one complete revolution to get the rollers on the base circles (and the piston on the firing stroke).
2. If pointer is not on 0-degree (on camshaft gear), remove the pointer and old spring dowels.

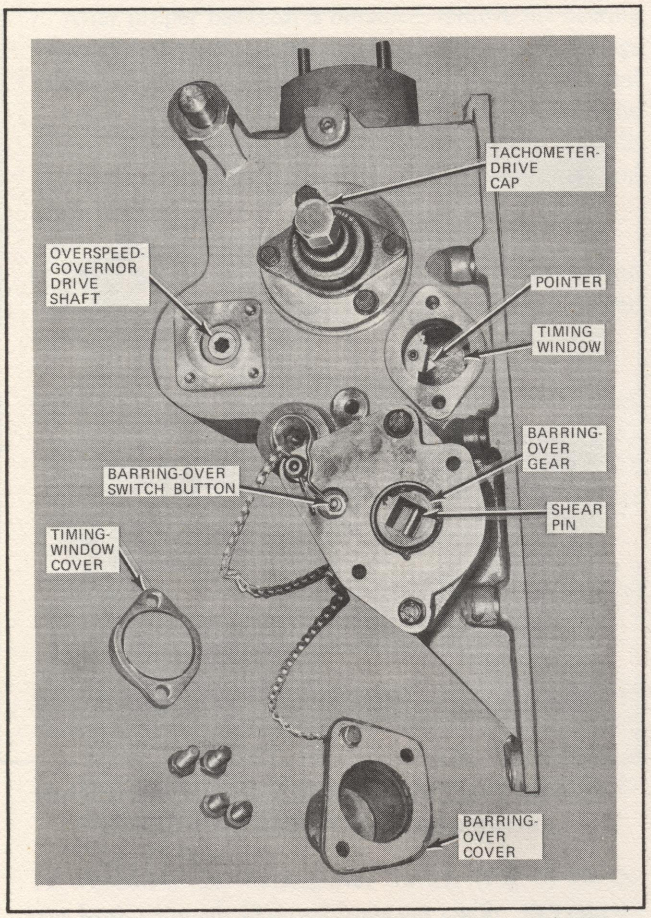

TACHOMETER-DRIVE CAP
OVERSPEED-GOVERNOR DRIVE SHAFT
POINTER
TIMING WINDOW
BARRING-OVER GEAR
BARRING-OVER SWITCH BUTTON
SHEAR PIN
TIMING-WINDOW COVER
BARRING-OVER COVER

FIG. 17. GOVERNOR DRIVE, FORWARD SIDE, WITH COVERS REMOVED.

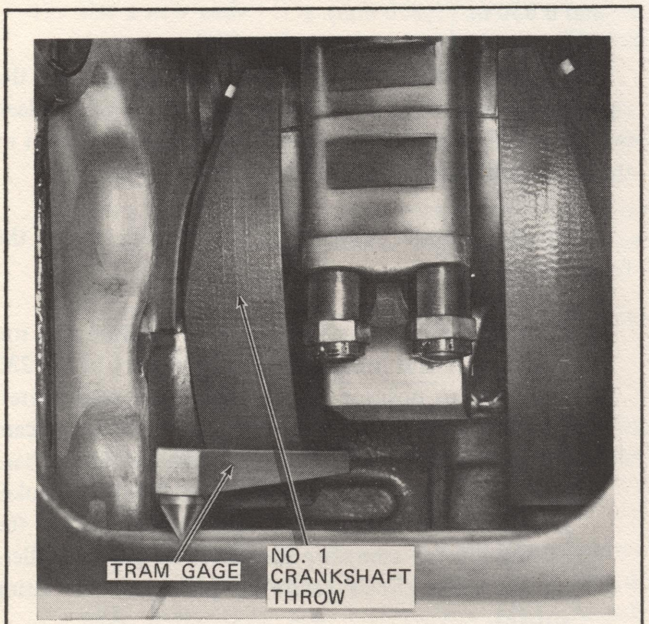

TRAM GAGE
NO. 1 CRANKSHAFT THROW

FIG. 18. POSITIONING CRANKSHAFT WITH TRAM GAGE, PART 147X1230.

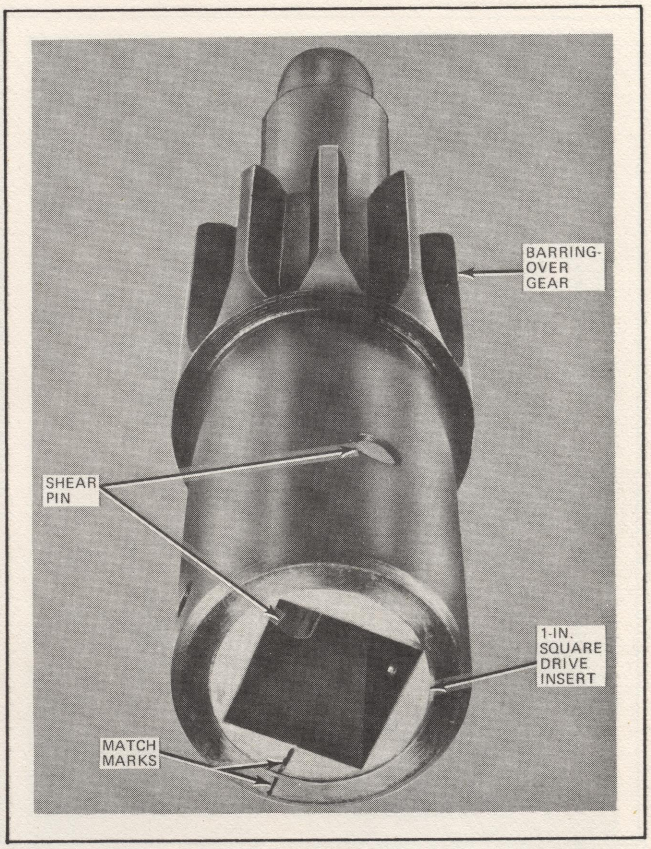

BARRING-OVER GEAR
SHEAR PIN
1-IN. SQUARE DRIVE INSERT
MATCH MARKS

FIG. 19. BARRING-OVER GEAR.

3. Reassemble the pointer and position so point is at 0-degree. Drill two new dowel holes thru pointer and into gear box. Holes should be 0.129-0.125 in. diameter and 1/2 in. deep.

> **CAUTION:** *Take precaution to keep chips from entering the governor drive assembly.*

4. Assemble two new spring dowels.

Assemble the timing-window cover and the barring-over cover.

Using new gaskets, assemble the control governor and overspeed governor. Assemble the overspeed-derater link, and reconnect the fuel-control linkage and all oil lines previously removed.

NOTE: *Make sure the spring (38) is in position before mounting the control governor.*

NOTE: *It may be necessary to reset the fuel injection pump racks after replacing a governor drive. See FUEL PUMP RACK SETTINGS in section DE-8.*

FIG. 17, E-23485
FIG. 18, E-10025
FIG. 19, E-23487

RENEWING BARRING-OVER GEAR SHEAR PIN

This operation can be performed without removing the governor drive from the engine.

With the engine stopped:

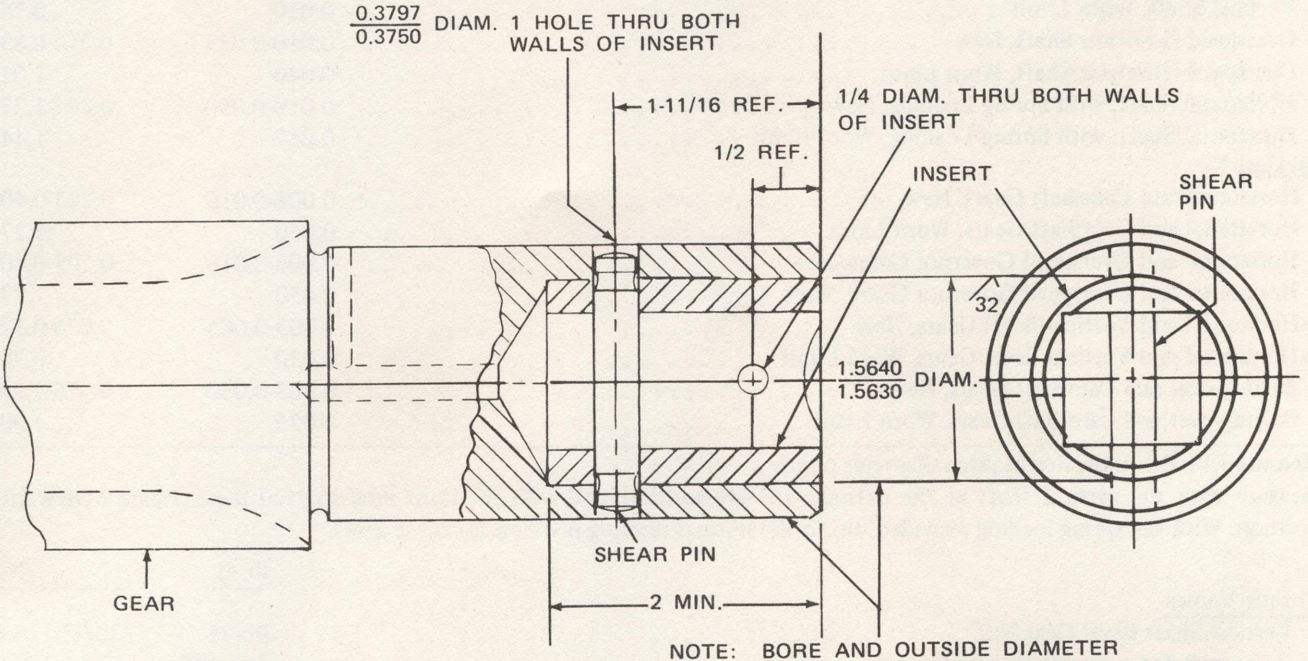
1. Push the barring-over gear in to engage the camshaft gear.
2. Apply a wrench to the 1-in. square hole, and rotate the insert to align the match marks (Fig. 19).
3. Pull the barring-over gear out to expose the ends of the shear pin. If required, form a wire hook to accomplish this operation.
4. Drive out all parts of the old shear pin.
5. Assemble a new shear pin and centralize so each end is equally depressed below the outside surface of the gear.

REPLACEMENT OF BARRING-OVER GEAR INSERT

NOTE: *In late-1979 the insert was changed to provide a 1-9/16 in. outside diameter instead of the previous 1-1/2 in. outside diameter. Only the 1-9/16 in. O.D. insert, Part 114X1148-1, is available for replacement. It will therefore be necessary to remachine the insert bore of older gears when first applying the new 1-9/16 in. O.D. insert.*

With the barring-over gear removed from the governor drive, replace the insert using the following procedure:

1. Remove the old shear pin and insert. Refer to preceding instruction, RENEWING BARRING-OVER GEAR SHEAR PIN, for suggested method of removing old shear pin.
2. If the old insert had a 1-9/16 in. outside diameter, examine the gear bore and remove all nicks and upset metal. If old insert had a 1-1/2 in. outside diameter, remachine the insert bore of the gear to a 1.5640/1.5630 in. diameter and to a 2 in. minimum depth. See Fig. 20.
3. Assemble the new insert in the gear bore and position it so the side surfaces of the 1-in. hole are parallel to, and square with, the shear pin holes.
4. Drill 0.3797/0.3750 in. diameter holes thru both walls of the insert.
5. Assemble a new shear pin and centralize so each end is equally depressed below the outside surface of the gear.
6. Drill 1/4 in. diameter holes thru both walls of the insert.
7. Apply a match mark to the face of the insert. See Fig. 19.


0.3797/0.3750 DIAM. 1 HOLE THRU BOTH WALLS OF INSERT
1-11/16 REF.
1/4 DIAM. THRU BOTH WALLS OF INSERT
1/2 REF.
INSERT
SHEAR PIN
32
1.5640/1.5630 DIAM.
SHEAR PIN
GEAR
2 MIN.

NOTE: BORE AND OUTSIDE DIAMETER MUST BE CONCENTRIC WITHIN 0.010 TIR

NOTE: ALL DIMENSIONS ARE IN INCHES.

FIG. 20, E-26303

FIG. 20. GEAR MODIFICATION.

DATA

	In.	mm
Gear Fits		
Main Drive Gear to Horizontal Shaft – Interference	0.002-0.004	0,051-0,102
Bevel Gear to Vertical Shaft – Clearance	0.0000-0.0015	0,000-0,038
Overspeed Governor Gear to Shaft – Clearance	0.0005-0.0015	0,013-0,038
Bearings, for Vertical Shaft, Overspeed Governor Shaft and Bearing Cap		
Interference Fit in Casting or Cap	0.0012-0.0027	0,030-0,069
Bore, before Assembly	1.130-1.129	28,702-28,677
Bore, after Assembly, Ream or Burnish	1.1263	28,608
Running Clearance, New	0.002-0.003	0,051-0,076
Running Clearance, Worn Limit	0.010	0,254
Bearings, for Fuel Control Shaft		
Interference Fit in Casting	0.0005-0.0025	0,013-0,064
Bore, before Assembly	1.002-1.001	25,451-25,425
Bore, after Assembly, Ream or Burnish	1.002-1.001	25,451-25,425
Running Clearance, New	0.001-0.004	0,025-0,102
Running Clearance, Worn Limit	0.010	0,254
Bearing, in Gear Box, for Barring-over Gear		
Interference Fit in Casting	0.002-0.004	0,051-0,102
Bore, before Assembly	1.2515-1.2505	31,788-31,763
Bore, after Assembly, Ream or Burnish	1.2498-1.2488	31,745-31,720
Running Clearance, New	0.0010-0.0047	0,025-0,119
Running Clearance, Worn Limit	0.010	0,254
Bearing, in Bearing Cap, for Barring-over Gear		
Interference Fit in Cap	0.002-0.005	0,051-0,127
Bore, before Assembly	2.0030-2.0015	50,876-50,838
Bore, after Assembly, Ream or Burnish	2.0025-2.0005	50,864-50,813
Running Clearance, New	0.0012-0.0052	0,030-0,132
Running Clearance, Worn Limit	0.010	0,254
End-Play		
Vertical Shaft, New	0.003-0.023	0,076-0,584
Vertical Shaft, Worn Limit	0.030	0,762
Overspeed Governor Shaft, New	0.010-0.033	0,254-0,838
Overspeed Governor Shaft, Worn Limit	0.040	1,016
Horizontal Shaft, with Spring Loading, New	0.010-0.050	0,254-1,270
Horizontal Shaft, with Spring Loading, Worn Limit	0.057	1,448
Backlash*		
Horizontal and Camshaft Gears, New	0.008-0.016	0,203-0,406
Horizontal and Camshaft Gears, Worn Limit	0.050	1,270
Horizontal and Overspeed Governor Gears, New	0.008-0.016	0,203-0,406
Horizontal and Overspeed Governor Gears, Worn Limit	0.050	1,270
#Horizontal and Vertical Bevel Gears, New	0.003-0.005	0,076-0,127
#Horizontal and Vertical Bevel Gears, Worn Limit	0.030	0,762
Barring-over and Camshaft Gears, New	0.003-0.050	0,076-1,270
Barring-over and Camshaft Gears, Worn Limit	0.075	1,905

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*Measure with dial indicator at pitch diameter of gear.

#Measure with the vertical shaft at the extreme DOWN position, and with the horizontal shaft at the extreme FORWARD position. With the spring loading provided, this is the normal running position for these gears.

	lb.-ft.	N·m
Torque Values		
Vertical Shaft Bevel Gear Nut	90-95	122,02-128,80
Overspeed Governor Shaft Gear Nut	200-225	271,16-305,06
Horizontal Shaft Spring Pack Nut	90-95	122,02-128,80

DE-5
8-79 (1000) WHT
8-80 (1000) WHT
8-81 (1500) WHT

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